What is claimed is:

1. An apparatus for measuring a set of frequency-resolved states of polarization of an optical signal comprising:

a local oscillator, the local oscillator comprising an initial polarization state;

a polarization scrambler, the polarization scrambler modulating the initial polarization state of the local oscillator to generate a polarization-scrambled signal;

a coupler, the coupler mixing the polarization-scrambled signal with at least a fraction of the optical signal to generate a heterodyned signal, the heterodyned signal comprising a radio frequency signal component; and

an analyzer, the analyzer passing a fixed polarization component of the at least the fraction of the optical signal and resolving the fixed polarization component in frequency from the radio frequency signal component.

2. The apparatus of Claim 1, wherein the analyzer further comprises:

a polarization analyzer, the polarization analyzer passing the fixed polarization component;

a photodetector, the photodetector detecting and converting the fixed output state of polarization of the radio frequency signal component to an electrical signal; and

a frequency analyzer, the frequency analyzer sampling the radio frequency signal component of the electrical signal in frequency.

3. The apparatus of Claim 2, wherein the frequency analyzer comprises a radio frequency spectrum analyzer.

4. The apparatus of Claim 3, wherein a dwell time of the radio frequency spectrum analyzer is longer than a time needed for the polarization scrambler to cover a Poincaré sphere.

5. The apparatus of Claim 2, wherein the frequency analyzer comprises a set of radio frequency bandpass filters.

6. The apparatus of Claim 1, wherein the local oscillator is tuned to yield a beat frequency, the beat frequency being equal to at least twice a bandwidth of the optical signal.

7. The apparatus of Claim 1, further comprising an optical out-coupler, the optical out-coupler tapping the at least the fraction of the optical signal from a working optical channel of an optical telecommunication system.

8. The apparatus of Claim 7, wherein the optical out-coupler comprises at least one of an optical grating, an etalon, a beamsplitter, and an optical coupler.

9. The apparatus of Claim 1, further comprising:

a polarization controller, the polarization controller set to sequentially produce at least two input polarization states of the at least the fraction of the optical signal through an optical device, wherein at least two sets of frequency-resolved states of polarization are measured at an output of the optical device, one for each of the at least two input polarization states; and

a processor, the processor calculating a polarization mode dispersion of the optical device transmitting the optical signal from the at least two sets of frequency-resolved states of polarization of the optical signal.

10. The apparatus of Claim 9, wherein the optical device is a working optical channel, the polarization mode dispersion of the working optical channel being calculated from the at least two sets of frequency-resolved states of polarization of the optical signal.

11. The apparatus of Claim 10, further comprising a compensation system, wherein the processor further determines a compensation for feedback to the working optical channel, the compensation system receiving the compensation and modifying the optical signal to compensate for the polarization mode dispersion.

12. A method for measuring a set of frequency-resolved states of polarization of an optical signal comprising the steps of:

tuning a local oscillator to a first local oscillator frequency to generate a first local oscillator signal;

polarization-modulating an initial state of polarization of the first local oscillator signal to generate a polarization-scrambled signal;

mixing the polarization-scrambled signal with at least a fraction of the optical signal to produce a heterodyned signal, the heterodyned signal comprising a radio frequency signal component centered at a first beat frequency, the first beat frequency being equal to a

difference between the first local oscillator frequency and a carrier frequency of the optical signal;

analyzing frequency components and polarization components of the radio frequency signal component; and

generating a first set of frequency-resolved states of polarization from the frequency components and polarization components.

13. The method of Claim 12, wherein the step of analyzing further comprises:

passing a fixed polarization component of the heterodyned signal through an adjustable polarization analyzer set to a fixed position;

converting the fixed polarization component of the heterodyned signal to an electrical signal; and

resolving the frequency components of the fixed polarization component.

14. The method of Claim 13, wherein the step of converting the heterodyned signal to an electrical signal includes detecting the heterodyned signal with a fast photodetector.

15. The method of Claim 13, wherein the adjustable polarization analyzer comprises at least three fixed positions, and further wherein the steps of passing, converting and resolving are performed at least three times, once for each of the at least three fixed positions to generate frequency-resolved measurements of at least three fixed polarization components.

16. The method of Claim 15, wherein the at least three fixed polarization components comprise one of a horizontal and vertical linear polarization state, one of a 45-degree and a 135-degree linear polarization state, and a circular polarization state to generate at least three frequency-resolved measurements of the at least three fixed polarization components.

17. The method of Claim 16, wherein the step of generating the first set of frequency-resolved states of polarization comprises calculating a set of frequency-resolved Stokes parameters from the at least three frequency-resolved measurements of the at least three fixed polarization components.

18. The method of Claim 12, further comprising the steps of:

tuning the local oscillator to a second local oscillator frequency to generate a second local oscillator signal;

polarization-modulating a second initial state of polarization of the second local oscillator signal to generate a second polarization-scrambled signal;

mixing the second polarization-scrambled signal with at least the fraction of the optical signal to produce a second heterodyned signal, the second heterodyned signal comprising a second radio frequency signal component centered at a second beat frequency, the second beat frequency being equal to a difference between the second local oscillator frequency and the carrier frequency of the optical signal;

analyzing a second set of frequency components and polarization components of the second radio frequency signal component; and

generating a second set of frequency-resolved states of polarization from the second set of frequency components and polarization components.

19. The method of Claim 18, further comprising the steps of:

combining the first set of frequency-resolved states of polarization with the second set of frequency-resolved states of polarization to form a combined set; and

smoothing a noise component in the combined set.

20. The method of Claim 12, wherein the optical signal is from a working channel of an optical telecommunication system, the method further comprising the step of tapping the at least the fraction of the optical signal from the working channel for mixing with the polarization-scrambled signal.

21. A method for measuring a polarization mode dispersion of an optical device, comprising the steps of:

(a) tuning a local oscillator to a local oscillator frequency to generate a local oscillator signal;

(b) polarization-modulating an initial state of polarization of the local oscillator signal to generate a polarization-scrambled signal;

(c) passing at least a fraction of an optical signal through a polarization controller, the polarization controller set to produce one of at least two input polarization states;

(d) transmitting the optical signal through the optical device, after the step of passing the at least the fraction of the optical signal through the polarization controller;

(e) mixing the polarization-scrambled signal with the at least the fraction of the optical signal at an output of the optical device to produce a heterodyned signal, the heterodyned signal comprising a radio frequency signal component centered at a beat frequency, the beat frequency being equal to a difference between the local oscillator frequency and a carrier frequency of the optical signal;

(f) analyzing frequency components and polarization components of the radio frequency signal component;

(g) generating a set of frequency-resolved states of polarization from the frequency components and polarization components corresponding to the one of the at least two input polarization states; and

(h) repeating steps (a) through (g) for each of the at least two input polarization states to generate at least two sets of frequency-resolved states of polarization corresponding to the at least two input polarization states; and

(i) calculating the polarization mode dispersion of the optical device from the at least two sets of frequency-resolved states of polarization.

22. The method of Claim 21, wherein the optical device comprises a working channel of an optical telecommunication system, the method further comprising the step of tapping the at least the fraction of the optical signal from the working channel for mixing with the polarization-scrambled signal.

23. The method of Claim 22, further comprising the steps of:

determining a correction factor for compensating the polarization mode dispersion of the working channel; and

applying the correction factor to the optical signal to compensate the polarization mode dispersion in the working channel.

24. The method of Claim 21, wherein the polarization controller provides the at least two input polarization states alternatingly in time.

25. The method of Claim 24, wherein the at least two input polarization states is at least three input polarization states.